REMARKS

Claims 11, 13-22, 24-28, 34-45, 47-50, 52-61, and 63-65 are pending. Claims 1-10, 12, 23, 29-33, 46, 51, and 62 are withdrawn.

Summary of Discussion with Examiner

Applicants' representative (Mindy N. Rittner, Reg. No. 57,803) spoke with Examiner Shahrestani by telephone on Tuesday, June 15, 2010, to schedule an interview to discuss the present application. Examiner Shahrenstani was in agreement, and he proposed a tentative date for an interview that would include himself, his supervisor, inventor J. Gary Eden, and Applicants' representative. A brief discussion of the case ensued, and Examiner Shahrestani requested that a response be filed prior to scheduling and conducting the interview. Applicants' representative will contact Examiner Shahrestani after filing the present response to confirm the date and time of the interview.

Rejections of the Claims Under 35 U.S.C. §103

Claims 11, 13, 14, 16-21, 26-28, 34-43, 45, 47-49, 52, 53, and 59-64 stand rejected under 35 U.S.C. §102(e) as being unpatentable over U.S. Patent 7,075,055 ("Nagai") in view of U.S. Patent 6,871,084 ("Kingsley"). Claims 22, 24, 50 and 51 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nagai and Kingsley in view of U.S. Patent Application Publication 2002/0149832 ("Matsushita"). Claims 54-58 stand rejected under 35 U.S.C. 103(a) over Nagai and Kingsley and further in view of U.S. 2002/0173714 (Tsukada).

Applicants respectfully disagree. Independent claims 11 and 40 are directed to a detection apparatus to detect magnetic fields and a method of detecting magnetic fields, respectively. Claims 13, 14, 16-21, 26-28, and 34-39 depend from claim 11, and claims 45, 47-49, 52, 53, and 59-64 depend from claim 40. Applicants point out that

claim 65, which depends from claim 40, is not included in the rejection. The patentability of each independent claim is discussed below.

Independent claim 11 recites a detection apparatus to detect magnetic fields comprising: a first magneto-optical element that exhibits a response, in the form of Faraday rotation, to an applied magnetic field, a hysteresis characteristic of the Faraday rotation exhibiting transition regions between a plurality of stable states; a light source to emit light that impinges on the first magneto-optical element; a modulation element comprising a coil adjacent to the first magneto-optical element, the modulation element being a source of a time-varying magnetic field of sufficient strength to switch the first magneto-optical element between the stable states; and a detector configured to detect a change in the light caused by a reaction of the first magneto-optical element to a magnetic field of a subject, the change occurring when the first magneto-optical element is in one of the transition regions.

On page 3 of the Office action, Examiner Shahrestani asserts that "Nagai teaches a measuring device comprising a first magneto-optical medium (structure 48) that exhibits a response in the form of Faraday rotation (col. 17 lines 34-39) by the application of a magnetic field and *exhibition of hysteresis characteristics*." (emphasis added)

In fact, Nagai does ***not*** teach a measuring device comprising a magneto-optical medium that exhibits a Faraday response including hysteresis. The underpinning of Nagai's invention is that the Faraday response to an external magnetic field must be ***linear***. Hysteresis is not linear. Nagai explains that a "magneto-optical effect handled here is a *linear* effect of magnetization and a magnetic field, and it is supposed that the effect caused by a magnetization vector in any direction is allowed to be considered by separating the magnetization vector into components of any direction. A magnetic Kerr effect and a Faraday effect are *linear* effects of magnetization and the magnetic field." (col. 8, lines 64 – col. 9, line 3; emphasis added)

Nagai emphasizes the need for linearity – as opposed to hysteresis – in the response of the magnetic film used in his measuring device in col. 49, lines 5-16: "If a magnetic film with in-plane magnetization is used, hysteresis to an in-plane magnetic field is easily caused and response to the in-plane magnetic field does not become linear. Using the magnetic film with perpendicular magnetization, the hysteresis to the in-plane field decreases and the linearity of sensitivity becomes excellent." Accordingly, to avoid hysteresis, Nagai teaches that "the magnetic substance [used] is a magnetic film with perpendicular magnetization."

Applicants point out that the mere recognition by Nagai that it is possible to select a magnetic film exhibiting hysteresis ***does not constitute a disclosure of a detection apparatus that includes such a film***. As discussed above, there is no disclosure whatsoever in Nagai of a detection apparatus having a magneto-optical element that exhibits a response in the form of Faraday rotation to an applied magnetic field, where a hysteresis characteristic of the Faraday rotation exhibits transition regions between a plurality of stable states, as required by claim 11. To the contrary, throughout the specification, Nagai advocates the opposite – the selection of a magneto-optical element that exhibits a ***linear*** Faraday response to an applied magnetic field. Linearity is critical to the operation of Nagai's measuring device, and hysteresis undermines every embodiment of Nagai's invention. One of ordinary skill in the art would not be inclined, based on the teachings of Nagai, to arrive at a detection apparatus including a magneto-optical element that exhibits hysteresis in response to a magnetic field, as required by Applicants' claims.

Nagai also fails to teach or suggest the modulation element of claim 11, as Examiner Shahrestani acknowledges on page 3 of the Office action: "Nagai does not teach the modulation element comprising a coil adjacent to the first magneto-optical element, the modulation element being a source of a time varying magnetic field." The Examiner then states that "Kingsley et al. teach a high impedance optical electrode comprising an optical fiber (element 28), wrapped like a coil thereby producing a phase modulation in light (element 22) that resides inside the optical fiber (col. 19 lines 38-44).

It would have been obvious to one of ordinary skill in the art at the time of invention to have modified Nagai and to have integrated the teachings of Kingsley et al. in order to provide a coiled optical modulation element that would assist in reducing noise."

An optical fiber "wrapped like a coil" does not constitute a modulation element comprising a coil that is a ***source of a time-varying magnetic field of sufficient strength to switch the first magneto-optical element between the stable states***, as recited by claim 11. As would be recognized by one of ordinary skill in the art, a coil capable of generating a time-varying magnetic field that would satisfy the limitations of claim 11 is a coil that carries electric current. A coil carrying light does not generate such a field. The light traveling through the coil would generate an almost imperceptible magnetic field that could not be detected outside the coil, much less be of sufficient strength to switch the first magneto-optical element between the stable states, as required by the claim.

Taken alone or in combination, the references cited by the Examiner fail to teach or suggest each and every feature of independent claim 11.

Claim 40 recites a method of detecting magnetic fields that includes providing a first magneto-optical element exhibiting a response in the form of Faraday rotation to an applied magnetic field, where a hysteresis characteristic of the Faraday rotation exhibits transition regions between stable states, and impinging light from a light source on the first magneto-optical element. A time-varying magnetic field from a modulation element is also applied to the first magneto-optical element, and the first magneto-optical element is switched between the stable states. A change in the light caused by a reaction of the first magneto-optical element to a magnetic field of a subject is detected, the change occurring when the first magneto-optical element is in one of the transition regions.

Although this claim stands rejected over Nagai in view of Kingsley, the Office action ***fails to identify any portion of either reference*** that teaches or suggests (1) applying a time-varying magnetic field from a modulation element to the first magneto-

optical element, and (2) switching the first magneto-optical element between the stable states. When this issue was raised during the June 15 telephone call summarized above, Examiner Shahrestani indicated that MRI systems carry out such steps. Although no specific reference has been cited in support of this assertion, Applicants will address this misconception in an effort to expedite prosecution.

MRI was developed as a means to image tissue and is based on the absorption and emission of radio-frequency (RF) energy by certain nuclei that are immersed in a constant magnetic field. In this situation, magnetic nuclei will preferentially align with the direction of the state magnetic field and will absorb RF energy at specific (resonant) frequencies. The selectivity of the absorption of particular frequencies by a given nucleus opens the door to identifying specific atoms in tissue. This is done by simply changing the frequency of the RF energy. The environment that each nucleus "sees" is determined by the rate at which the nucleus re-emits the RF energy after the source is turned off. A more detailed discussion of MRI can be found in *Introduction to Bioengineering*, Berger, Goldsmith, and Lewis, eds. (Oxford, 2004).

As would be apparent to one of ordinary skill in the art, MRI does not involve applying a time-varying magnetic field from a modulation element to a magneto-optical element, as required by claim 40, nor does MRI entail switching a magneto-optical element between the stable states. Indeed, MRI has little in common with the claimed invention. If Examiner Shahrestani believes that steps of the claimed invention are carried out in MRI systems, he is respectfully requested to provide a reference supporting that assertion.

Applicants also point out that the method of claim 40 requires providing a first magneto-optical element exhibiting a response in the form of Faraday rotation to an applied magnetic field, where a *hysteresis characteristic of the Faraday rotation exhibits transition regions between stable states*. As discussed in detail above in reference to claim 11, Nagai fails to teach or suggest a detection method employing a magneto-optical element exhibiting the claimed hysteresis in response to an applied magnetic field.

Finally, Applicants' method requires detecting a change in the light caused by a reaction of the first magneto-optical element to a magnetic field of a subject, ***where the change occurs when the first magneto-optical element is in one of the transition regions***. This is an important feature of the invention, as the detection method exploits the steep transition between the stable states to improve dramatically the capability to detect weak magnetic fields. Both Nagai and Kingsley fail to teach or suggest this step of the claimed method. Indeed, the Examiner appears to appreciate this, as the Office action fails to point to any portion of either reference that discloses this feature of the claims.

Since the prior art of record in this case does not teach or suggest each and every element of independent claim 11 or 40, a *prima facie* case of obviousness cannot be established with respect to these claims or any claims depending therefrom. Accordingly, Applicants respectfully request that the Examiner withdraw the rejection of claims 11, 13-22, 24-28, 34-45, 47-50, 52-61, and 63-65 under 35 U.S.C. §103(a).

Summary

Applicants respectfully submit that the pending claims are in condition for allowance. The Examiner is invited to contact the undersigned agent for the Applicant via telephone if such communication would expedite allowance of this application.

Respectfully submitted,

Dated:

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